INSTRUCTION MANUAL

DELUXE LABORATORY CHART RECORDERS

8373 - 10 - 20 - 30

MP MASTER
MA34830

Cole Parmer

Cole-Parmer Instrument Company
7425 North Oak Park Avenue, Chicago, IL 60648
1-708-647-7600 or toll-free 1-800-323-4340 (except Alaska)
Fax: 1-708-647-9660 Telex: 28-9405

This manual provides information on how to properly use Cole-Parmer Recorders

Routine calibration, maintenance and basic trouble shooting is included to allow you to isolate a problem to a specific sub-assembly.

WARRANTY

Your Cole-Parmer Recorders are warranteed to be free of defects both in workmanship and in materials under normal use for a period of one year from the date of purchase by the user. This warranty specifically excludes expendables and consumables such as chart paper and pens.

Any obligation under this warranty is limited to the repair of the defective item or part thereof.

For service, both during and after warranty period, contact Cole-Parmer Instruments.

WARRANTY CARD

Please fill in and return the Warranty Registration Card, so we may validate the beginning date of the warranty year.

INITIAL INSPECTION

The recorder should be inspected for shipping damage after unpacking. If any damage is found, please notify the carrier and the Customer Service Department at Cole-Parmer. If the recorder fails to meet specifications, check all connections, cables and fuses. Insure that all plug-in boards are firmly seated in place. Double check for "PILOT ERROR" before calling Cole-Parmer. Please save packing material until recorder operation is confirmed. Do not return instrument without proper identification as to recorder problem. Do not return paper and pens.

INQUIRIES

To avoid lengthy delays in processing orders or correspondence regarding your recorder, please include the recorder model number, serial number and options.

TABLE OF CONTENTS

INTRODUCTION

INITIAL INSPECTION/INQUIRES

RECORDER CHARACTERISTICS

SET-UP PROCEDURES
- Fuse Requirements
- Chart Paper Installation
- Pen Installation
- Power Requirements
- Grounding
- Input Signal Connections
- Initial Recording/Calibration

GENERAL THEORY
- DC Power Supply
- Pen Drive System
- Chart Drive System
- Paper Release System
- Remote Chart Control
- Remote Chart Programming/TTL

OPERATIONAL TIPS AND MAINTENANCE

FIELD CALIBRATION PROCEDURES
- Power Supply
- Chart Drive System
- Pen Drive System

TROUBLESHOOTING

ACCESSORIES/PARTS/SUB-ASSEMBLIES

SPECIAL FEATURES

DIAGRAMS

INTRODUCTION

The DC Analog recorder is an application of advanced electronic techniques. Its solid state modular circuitry yields high performance and reliability.

This graphic recorder may be used in many different applications in the medical, teaching, and industrial fields where a precision instrument is of utmost importance.

Measurement of DC voltage, current, temperature, and a variety of other variables are made possible with the use of the recorder.

RETURN REQUESTS/INQUIRIES

DO NOT return recorder to dealer or factory without authorization from the service department.

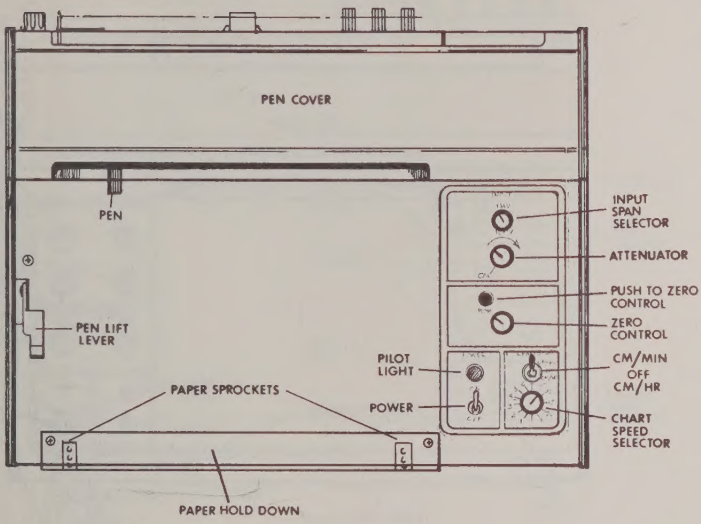
To avoid lengthy delays in processing orders or correspondence, please include the recorder model number, serial number, and options.

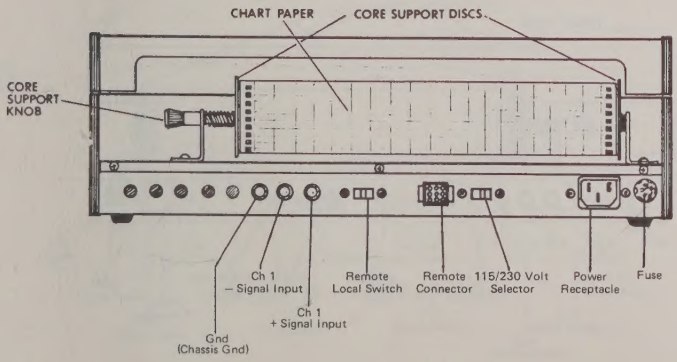
INITIAL INSPECTION

Your recorder is warranted to be free of defects both in workmanship and in materials under normal use for a period of one year from the date of purchase.

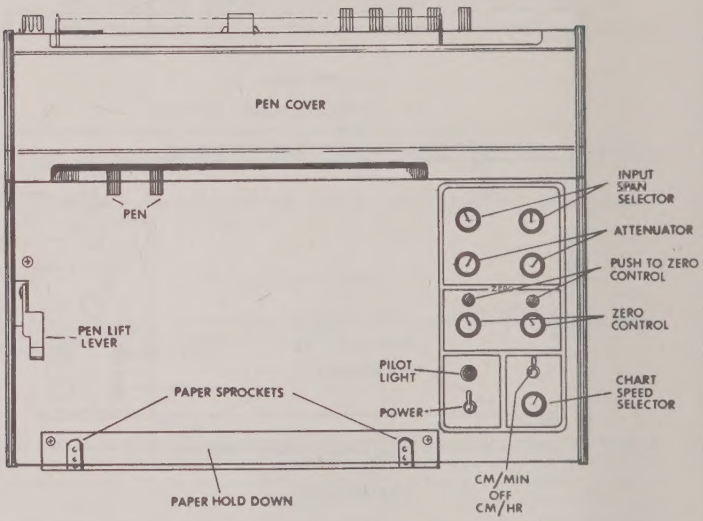
The recorder should be inspected for shipping damage after unpacking. If any damage is found, please notify the carrier and the customer service department at Linear. If the recorder fails to operate properly, check all connections, cables, and fuses. Insure that all plug-in boards are firmly seated in place. Double check for "Pilot Error" before calling your local dealer the instrument was purchased through, or factory direct. Please save packing material until recorder operation is confirmed.

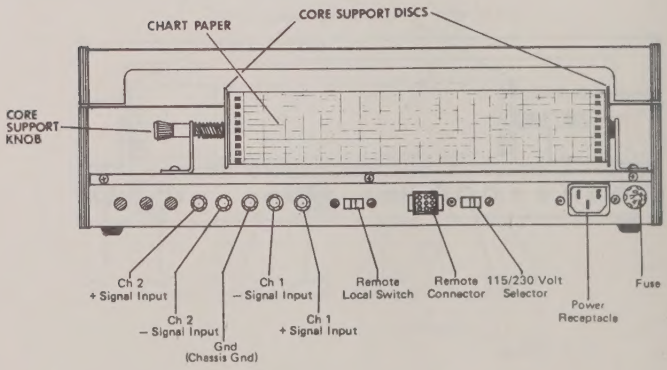
SINGLE CHANNEL MODEL



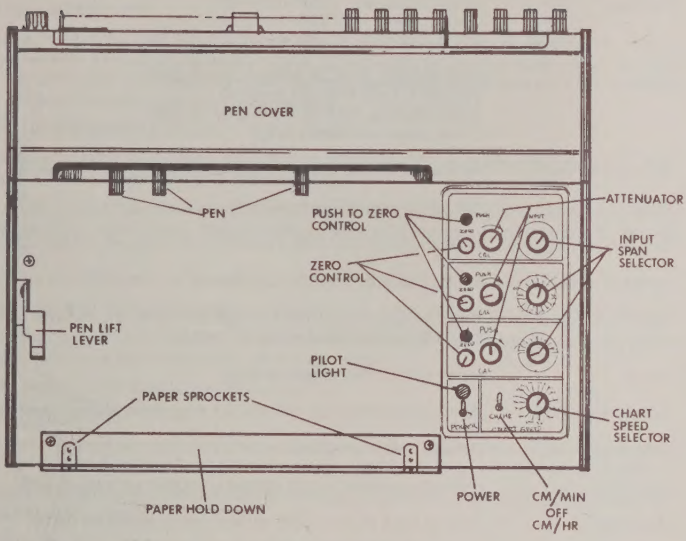


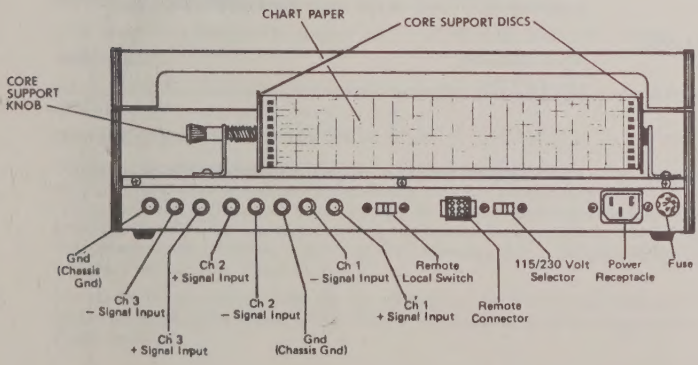
DUAL CHANNEL MODEL





THREE CHANNEL MODEL





RECORDER CHARACTERISTICS

Power:	115/230 VAC ± 10%, 50/60 Hz, 1 0.
Wattage:	Single Channel 21W nominal Dual Channel 29W nominal Triple Channel 38W nominal
Fuse:	3 AG Slo-Blo, 0.3A @ 115V; 0.15A @ 230V (Single & Dual channel models) 3 AG Slo-Blo, 0.6A @ 115V; 0.3A @ 230V (Triple channel models only)
Writing Method:	Pens are disposable fiber tipped units with self-contained ink supply.
Chart:	250 mm width; 30 meter length.
Dimensions:	14.3 cm (5.625") H X 45.7 cm (18") W X 35 cm (13.75") D
Weight:	5.7 Kg (12.5 lbs) to 7.25 Kg (16 lbs).
Span-Full Scale	1 mv through 5 v (10 mv through 50 v with uncalibrated 10:1 attenuator) Depending on model.
Input:	Floating (± 100 v single ended.)
Input Impedance:	20 megohms through 100 mv, 2.5 megohms through 5 volts.
Pen Response:	Greater than 70 cm/sec.
Damping:	Critically damped on all ranges (requires no adjustment).
Accuracy:	Overall limit of error from all sources is less than 0.5%.
Zero Adjust:	Continuously adjustable from -100% to +100% (full scale +100% suppression) on each range. Right hand zero is standard.
Common Mode Rejection:	80 db minimum DC to 60 Hz 100 volts maximum
Chart Speeds:	1, 2, 3, 4, 5, 6, 10, 12, 15, 20 and 30 cm/min and cm/hr.
Chart Accuracy:	Internal crystal controlled oscillator or external TTL pulse train.

SET UP PROCEDURES

The procedures, detailed in the following paragraphs, must be performed to prepare the recorder for operation.

FUSE REQUIREMENTS

Check unit for proper fuse, located on back panel of recorder. Units are shipped on 115V Hz position with a .3A fuse installed. For 230V 50 Hz operation a .15A fuse should be used (included with your recorder). For three channel instruments a .6A fuse for 115V operation and a .3A fuse for 230V operation is required.

CHART PAPER INSTALLATION

1. Remove masking tape from new roll of chart paper and cut or tear each side to form a blunt point at the center. (DO NOT FOLD.)
2. Pull the knob on the right side of the chart paper core support, located on the rear panel of the recorder. Install paper, making sure it seats evenly on the two core supports. Release knob.
3. Lift the pen lift lever (on the left side of the instrument) to the full upright position.
4. Manually feed the pointed paper under the pen cover and across the writing area.
5. Pull the paper under the paper hold down and across the paper sprockets, making sure the holes in the paper sit evenly on the sprockets.
6. The paper is now loaded for operation.

PEN INSTALLATION

1. Remove the pen cap and store it where it can easily be found. Pens can be left uncapped for long periods of time, but greater pen life results from capping when not in use.
2. Slide the pen into the pen carriage and gently push back until the nib is firmly seated against the carriage.
3. Return the pen lift lever to the original down position.

POWER REQUIREMENTS

Your recorder is designed to operate on 115 or 230 VAC, 50/60 Hz, 1 phase.

IMPORTANT:

Be sure to set the conversion slide switch, located on the back panel, to match the correct line voltage.

GROUNDING

For best performance, the green (or green and yellow) ground wire in the power cord for the recorder and the signal source should share a common water pipe ground. The green (green and yellow) wire, in the power cord, is connected to the recorder ground (chassis); but not to the signal input. If the signal input does not have a third wire in its power cord, or if the instrument is not grounded, connect a wire between the recorder ground (green terminal) and the chassis of the signal source.

In case of large common-mode signals, particularly 120 Hz, connect the recorder ground (green terminal) to the source of the common-mode signal, or to the negative recorder input (black terminal).

INPUT SIGNAL CONNECTIONS

This instrument requires a DC voltage input. Signal sources with current outputs will require a shunt resistor across the + (red) and - (black) inputs. Ohms law may be used to compute the proper value for a given input range. The formula is:

$$R = \frac{E}{I}$$

Where E is the recorder span range selected in volts.
I is the maximum current signal to be recorded in amps.
R is the resistance of the shunt resistor in ohms.

Electrical connections are made as follows:
Signal source positive to recorder Red (+) terminal.
Signal source negative to recorder Black (-) terminal.

Right hand chart zero is standard on the recorder. Positive going signals drive pen to the left. If an opposite presentation is desired, reverse the input leads and use the zero adjust control to position the pen to the opposite side of the chart. Negative signals will now drive the pen to the right.

Note: This unit is calibrated for right hand zero. Reversal of the input leads may yield a ± 3% full scale error.

RECORDING PROCEDURE

With chart paper and pen(s) installed and recorder plugged into proper AC source (corresponding to the conversion slide switch on the back of the recorder) perform the following steps for routine recording:

1. Turn power switch on and chart switch off.
2. Set input span to desired range and attenuator to Cal position.
3. Push zero button.
4. Zero pen to right side of chart using zero control knob.
5. Release zero button and apply input signal.
6. Adjust input span and attenuator for desired full scale range to best display input signal.
7. Turn chart drive on and set chart speed as desired. Make sure the chart paper holes are properly aligned with sprocket teeth.

NOTE 1: When switching from one sensitivity range to another, it may be necessary to rezero the pen. To do so, push zero button and readjust the zero knob. (The zero knob has no stops at the end of mechanical travel.)

NOTE 2: In most models the input resistance is so high that the pen may drift when no connections are present at the input.

NOTE 3: If the pen is physically stalled on the chart for a few seconds, the servo system will shut down to protect the motor. The best way to reset the system is to turn the recorder off for about 5 seconds, and then back on. Pen should reactivate and continue to record normally.

If the shutdown resulted from an overrange, the recorder will operate normally as soon as the input signal decreases to a level which is within the selected span range.

GENERAL THEORY

The DC input signal to the recorder is first filtered, then amplified by the preamp to a level which is less susceptible to noise and interference. This conditioned signal is then applied to the servo amplifier which continuously compares it to the feedback signal developed by the servo potentiometer.

The difference between these two signals is a positive or negative error signal that is amplified and used to drive the servo motor, which is coupled to the servo potentiometer, in a direction as to reduce the error signal to zero. Since the recorder pen is mechanically coupled to the servo motor and servo potentiometer, its position on the chart represents an accurate and continuous permanent graphic record of the input signal. (See Figure 1.)

DC POWER SUPPLY

AC line voltage is reduced by stepdown transformers and converted to DC by solid state rectifiers and regulators. A stable DC voltage generated by a compensated zener diode is used as a reference for the servo pot.

PEN DRIVE SYSTEM

A DC servo motor is used to control the servo pot and recorder pen by means of a gear driven servo drum assembly. The pen is attached to a drive cable which is wrapped around and secured to the drum. As the drum rotates, the pen is moved across the chart proportionate to the amount of drum rotation.

CHART DRIVE SYSTEM

In this simple, reliable system an internal crystal oscillator generates pulses which are divided down by integrated circuit logic. The chart speed switch merely selects the appropriate pulse rate to drive the stepper motor at the desired speed. The crystal frequency is not a function of line frequency, therefore chart speeds are completely independent.

PAPER RELEASE CLUTCH

Your recorder is equipped with a sprocket release that enables you to advance or rewind the paper manually.

To advance or rewind the paper manually:

Lift the pen lift lever to the full UP position.

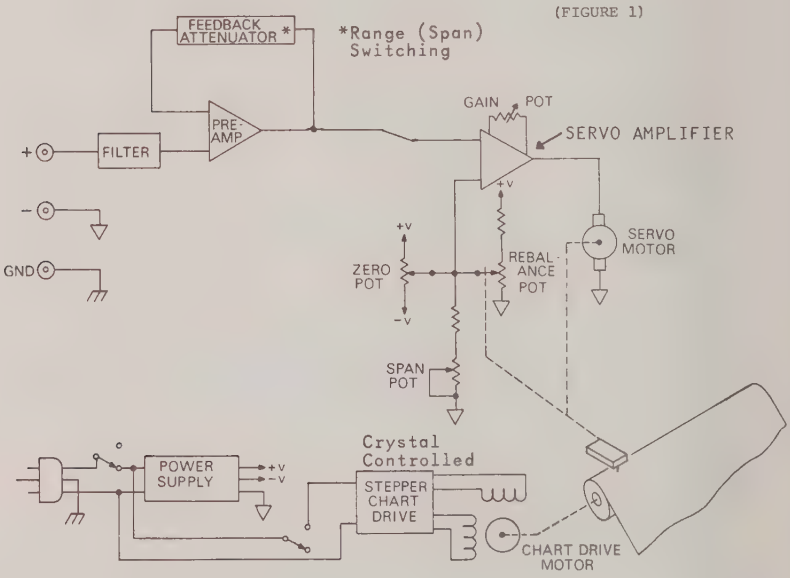
The paper may now be moved forward or backward as desired.

NOTE: After manual advancement or rewind there may be a few seconds delay, then the chart will run at the selected speed.

REMOTE CHART CONTROL

Place the Remote-Local slide switch in the "Remote" position. To start the chart drive from a remote location, apply a contact closure between pins 5 and 6 of the remote control connector located on rear panel of recorder. The chart will stop when the contact is opened.

(FIGURE 1)



REMOTE CHART PROGRAMMING/TTL

The recorder chart drive system is designed to operate from an external frequency source (including TTL levels). The chart can be run at time rates other than those built into the recorder. This mode is obtained by placing the Remote-Local slide switch (on rear panel of recorder) in the "Remote" position, and applying a pulse train, with the following characteristics; to pins 6 and 7 of the remote control connector, pin 7 being common.

PULSE TRAIN SPECIFICATIONS

0 (Lo) state voltage is + 0.5V or less.
1 (Hi) state voltage is + 3 to +10 volts maximum.
Minimum pulse width: 100 microseconds.

Pulse frequencies up to 10K Hz may be used, providing the chart speed selector switch is set to limit the actual chart movement to 50 cm/min or less. A 50 cm/min paper speed can be obtained by applying a 250 Hz external frequency and setting the chart selector switch in the 30 cm/min position.

The formula is: Chart Speed $= \frac{F}{150 \text{ Hz}} \times S$

Where: F = external frequency in Hz
S = selected chart speed

When the external frequency is set to 150 Hz, the chart drive will run at the speeds marked on the top panel selector switch.

If the external frequency is increased (or decreased) by 10% of the standard 150 Hz rate, the actual chart speed will be 10% faster (or slower in the case of a decrease) than the setting on the panel selector switch.

EXAMPLE: The selector switch is set at 30 cm/min and the external frequency is changed to 165 Hz (a 10% increase). The chart paper will now run at 33 cm/min.

NOTE: Changes of external frequency effects all selector speed rates by the same factor.

The recommended maximum chart speed for Start Stop operation is 50 cm/min. If the frequency is "swept" (no Start Stop), it is possible to run faster than 50 cm/min; however, sweep rate must be gradual enough to assure accurate mechanical tracking.

OPERATIONAL TIPS AND MAINTENANCE

Chart paper and pens have been carefully matched for optimum writing and minimum "bleed." Substitutions could cause improper writing. Keep pen tips covered when not in use to prolong writing life.

NOTE: If the pen is left uncapped for long periods and dries out, it may be revitalized by dipping in water for a few seconds.

Do not press down or otherwise manually force the paper hold down bracket This could cause pinching of the paper as it feeds over the sprockets. Firm tension on paper roll and correct alignment of the paper hold down bracket are required for proper chart paper feed.

Allow recorder to warm up for about 30 minutes if high accuracy/stability recording is desired.

The exterior surfaces of the recorder may be treated with "Armor All " (manufactured by Very Important Products, Inc.) and wiped clean with a dry cloth. Solvents should not be used as they may damage or destroy the finish.

NOTE: Mechanical components of the recorder must not be lubricated with WD-40, 3 in one oil, or similar products. They may impair instrument performance and void warranty. If lubrication is required, contact your local service representative.

FIELD CALIBRATION PROCEDURES

This recorder is designed to be simple, reliable, easy to maintain and repair. Therefore, the procedure presented here will be as simple, clear, and brief as possible. For special problems, we recommend contacting your local representative or factory service department.

CALIBRATION

Power Supply

There are no calibration adjustments in the power supply. Barring failure, the reference voltages will remain constant and stable.

Chart Drive System

The stepper drive printed circuit board has no calibration adjustments. Barring failure or gear binding, the stepper drive printed circuit board and stepper motor should give many years of reliable service. If a problem should arise, consult your local representative or factory service department.

Pen Drive System

The calibrations covered in this section should be performed by a qualified technician. The technician must have knowledge of working around voltages which may cause an electrical shock.

NOTE: Gain, offset and span must be adjusted for each channel in multipen units.

1. Gain

   The gain adjustment controls the servo loop gain or "dead band" of the recorder. This can be reached through a hole in the bottom of the recorder marked GAIN. If set too high, the pen will "buzz." If set too low, the pen will be sluggish.

To Calibrate:

A. Short (+) and (-) inputs (red and black connectors on back of recorder) and set pen to center scale by turning the zero control.

B. Adjust gain control clockwise until pen "buzzes," then back off counterclockwise until buzzing stops.

C. Recheck the adjustment by moving the pen over full scale using the zero control. If pen "buzzes" at any point, turn gain control counterclockwise until the "buzzing" just stops.

2. Offset

This adjustment raduces the zero shift between input spans to a minimum value. Performance of this adjustment requires the recorder input to be switched between a short circuit and a 50K ohm resistor. Connect a 50K ohm resistor across the recorder's input binding posts (+ and –) and use a shorting jumper wire to short the input.

To Calibrate:

A. Allow the recorder to come up to operating temperature (30 minutes is suggested).

B. Remove the bottom panel of the recorder.

C. Connect the short across the input binding posts.

D. Place the range (span) switch in the 100mv setting (10mv setting on 2 range instruments).

E. Use the zero adjust knob to set the pen to mid-scale.

F. Switch the range switch to the 1mv position.

G. Return the pen to the setting in step "E" with the Eo potentiometer in the pre-amp circuit.

H. Remove the short which was connected in step "C."

I. Return the pen to the setting in step "E" with the Io potentiometer in the pre-amp circuit.

J. These adjustments are interactive so it will be necessary to repeat steps "C through I" until minimum pen movement is achieved.

K. Remove the 50K resistor and the shorting wire.

3. Span

This enables the technician to adjust the recorder,so that a calibrated full scale input signal will move the pen up to the full width of the chart. The first span adjustment can be reached through a hole in the bottom of the recorder marked SPAN. The second span adjustment is normally not necessary and the bottom panel must be removed to gain access to this adjustment.

To Calibrate:

A. Allow recorder to come up to operating temperature (30 minutes is suggested).

B. Set recorder in 1mv position and signal source to zero output.

C. Carefully set pen to zero by turning zero control.

D. Apply a 0.1% accuracy 1mv DC signal to the input.

E. Insert a screwdriver in the hole in bottom of recorder marked SPAN. Move adjustment until pen is at 100% position.

F. Check all input spans with proper inputs for 100% ± 0.5% deflection. Check zero for all ranges and reset as necessary.

NOTE: If spans for ranges from 200mv through 5v *DO NOT* deflect 100% ± 0.5% continue with the following steps:

G. Remove the bottom panel and set the range (span) switch to the 1v position. Check zero and reset as necessary.

H. Apply a 1v0.1% accuracy DC signal to the input.

I. Adjust the potentiometer located on the 4 lug terminal strip near range switch (on the inside of recorder) for 100% ± 0.5% pen deflection.

J. Check all inputs from 200mv to 5v with proper inputs for 100% ± 0.5% deflection. Check zero for all ranges and reset as necessary.

NOTE: For some models steps G through J are not applicable.

There are no additional calibration points on the recorders.

TROUBLESHOOTING

The modularity and simplicity of this recorder make it possible to isolate the problem area in many cases. Once you have done this, a quick call to your local representative or dealer office, will bring you needed advice or replacement part.

While it is impossible to think of every problem possibility, the following chart will give you suggestions on how to solve most problems.

ANALOG SECTION

SYMPTOM	PROBABLE CAUSE	REMEDY
Pilot light does not light, and recorder is inactive.	1. AC Power source disconnected.	1. Connect AC power source.
	2. Fuse blown.	2. Replace fuse.
	3. Conversion slide in wrong position.	3. Check slide switch on rear panel.
Pilot light on, but recorder inactive.	1. Signal input leads disconnected.	1. Check input connections.
	2. Preamp/servo driver circuit board loose in connector.	2. Check circuit board installation.
	3. Gain set too low.	3. Adjust gain control through hole in bottom of recorder.
	4. Defective preamp/servo driver circuit board.	4. Replace preamp/servo driver circuit board.
	5. Defective servo motor.	5. Replace servo motor.
Excessive Deadband	1. Gain set too low.	1. Adjust gain control through hole in bottom of recorder.
	2. Excessive common mode signal.	2. Connect ground terminal to source of common mode signal.
	3. Recorder ground not connected to signal source ground.	3. Provide a common ground for third wire (green or green and yellow) in power cords.
	4. Pen drive cable too loose.	4. Contact distributor or service rep.
	5. Pen carriage dragging on slide rod.	5. Contact distributor or service rep.

ANALOG SECTION

SYMPTON	PROBABLE CAUSE	REMEDY
Noise on pen trace	1. Noisy input signal from signal source.	1. Check signal source.
	2. Extremely noisy powerline.	2. Check powerline.
	3. Gain set too high.	3. Adjust gain control through hole in bottom of recorder.
	4. Recorder ground not connected.	4. Provide a common ground for third wire (green or green and yellow) in power cord.
	5. Defective bearing in servo motor.	5. Replace servo motor.
Pen trace has isolated steps.	1. Pen carriage slide rod dirty.	1. Contact distributor or service rep.
	2. Servo driver gain set too low.	2. Adjust gain control through hole in bottom of recorder.
	3. Defective servo motor	3. Replace servo motor.
	4. Defective servo pot.	4. Replace servo pot.
Pens will stop moving but will catch up if physically pushed.	1. Defective bearing in servo motor.	1. Replace servo motor.
Pen writes poorly.	1. Ink supply depleted.	1. Replace pen
	2. Pen tip dried out.	2. Revitalize by dipping in water for a few seconds.

CHART DRIVE SECTION

SYMPTOM	PROBABLE CAUSE	REMEDY
Chart Drive Inoperative.	1. Loose or defective power connections.	1. Check and repair power connections to stepper transformer.
	2. Defective chart drive motor.	2. Replace chart drive motor.
	3. Defective stepper chart drive circuit board.	3.(A) Check AC power connections to circuit circuit board. (B) Check DC voltages on circuit board. (C) Replace stepper chart drive circuit board.
	4. Gear train binding.	4. Contact distributor or service rep.
Continuous chart drive.	1. Defective capacitor across chart on-off switch.	1. Replace capacitor.
No chart drive in a particular chart speed	1. Loose or defective connections at chart speed selector and/or circuit board connector.	1. Check and repair connections.
	2. Defective component on circuit board.	2. Replace component or replace stepper chart drive circuit board.

ACCESSORIES

CHART PAPER	PART NUMBER
250 mm (10'' models)	8386-40
PENS	
For Single Pen Models	
Blue short nib	8377-05
Red short nib	8479-30
Black short nib	8479-34
For Dual Overlap Models	
Blue short nib	8377-05
Red short nib	8479-30
Black short nib	8479-34
Blue long nib	8479-31
Green long nib	8479-33
For Three Pen Models ONLY	
Blue short nib	8377-05
Red short nib	8479-30
Black medium nib	8373-04
Green long nib	8373-06

PARTS AND SUB-ASSEMBLIES

See the enclosed wiring diagrams.

For parts/sub-assemblies not listed, contact Cole-Parmer Instruments

IMPORTANT

Always specify model number, options, and serial number when ordering replacements parts and sub-assemblies.

SPECIAL FEATURES

OPTION 11 — MECHANICAL EVENT MARKER (*)

The mechanical event marker uses a separate solenoid actuated pen assembly to provide a short mark at the left edge of the chart when a contact closure is made between pins 1 and 2 of the remote control connector.

This special feature is available on one and two pen models only.

OPTION 12 — REMOTE CHART CONTROL

The remote chart control provides the ability to turn the chart drive on and off from a remote location when a contact closure is made between pins 5 and 6 of the remote control connector, and when the Remote-Local slide switch is in the "Remote" position.

This feature is standard on all deluxe laboratory chart recorders.

OPTION 13 — ELECTRIC PEN LIFT (*)

The electric pen lift provides a means by which the recorder pen(s) may be lifted off the chart, by an internal solenoid, when a contact closure is made between pins 8 and 9 of the remote control connector.

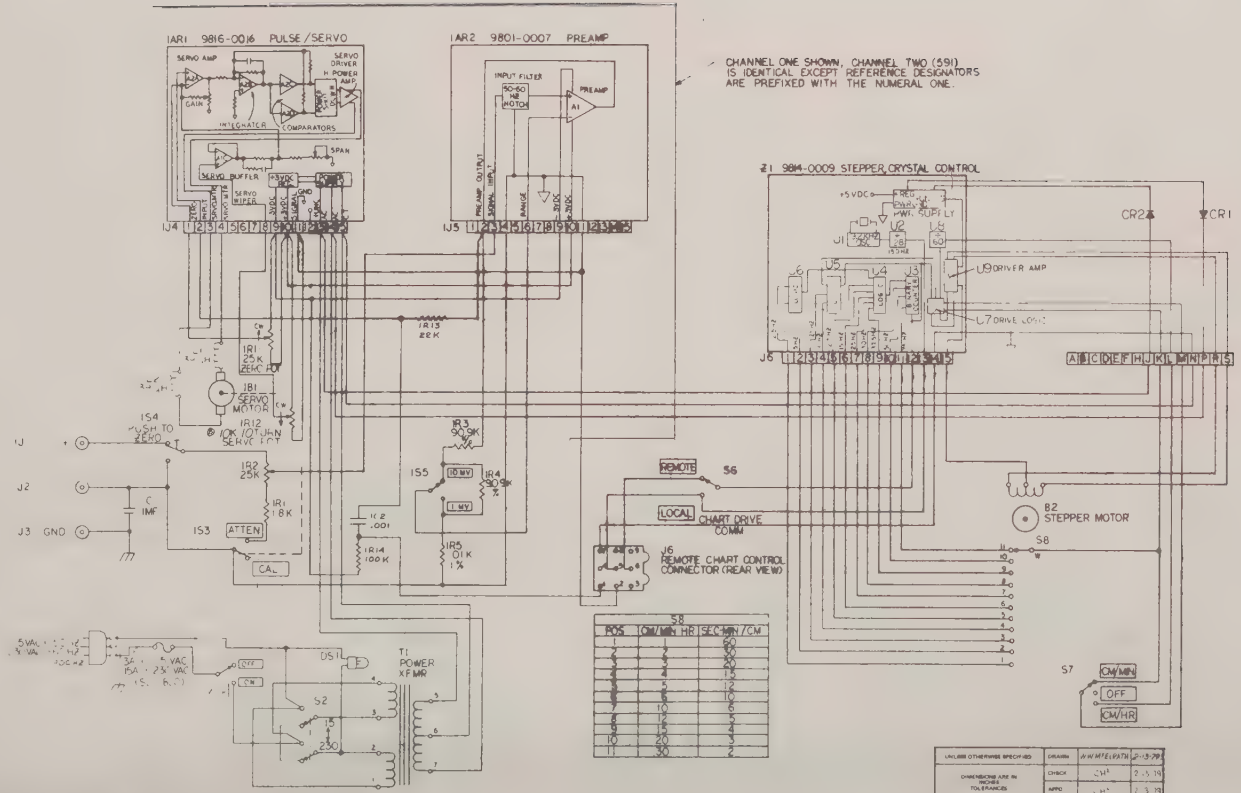
OPTION 16 — OVERRIDE EVENT MARKER (*)

This type of event marker produces a "glitch" in the pen trace when a contact closure is made between pins 3 and 4 of the remote control connector.

* Available at extra cost on all models, except as noted

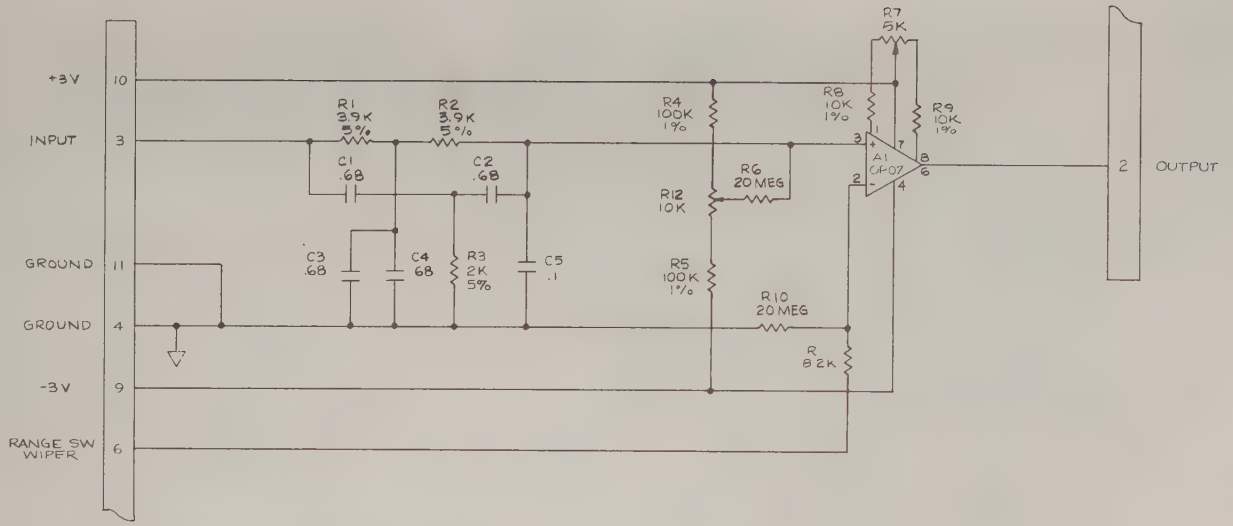
NOTE: Option 11, Mechanical Event Marker and Option 16, Override Event Marker:

1. On recorders with Option 16 standard (Manufacture date 1 July 1979 or later), this option will be wired to pins 1 and 2.
2. If a second Option 16, or an Option 11, is added in addition to the standard Option 16, it will be wired to pins 3 and 4.
3. If an Option 11 is installed in place of the standard Option 16, it will be wired to pins 1 and 2.
4. If two Option 16 and one Option 11, or three Option 16, are installed, then Option 13 (Electric Pen Lift) is not available and the third event marker will be wired to pins 8 and 9.



4 VOLTAGES SHOWN ARE NOMINAL
3 PANEL MOUNTED CONTROLS ARE IDENTIFIED BY BOXED NOMENCLATURE
2 CAPACITOR VALUES ARE IN MICROFARADS
1 RESISTOR VALUES ARE IN OHMS

Wiring diagram for Models 8373-10, 8373-20 and 8373-30



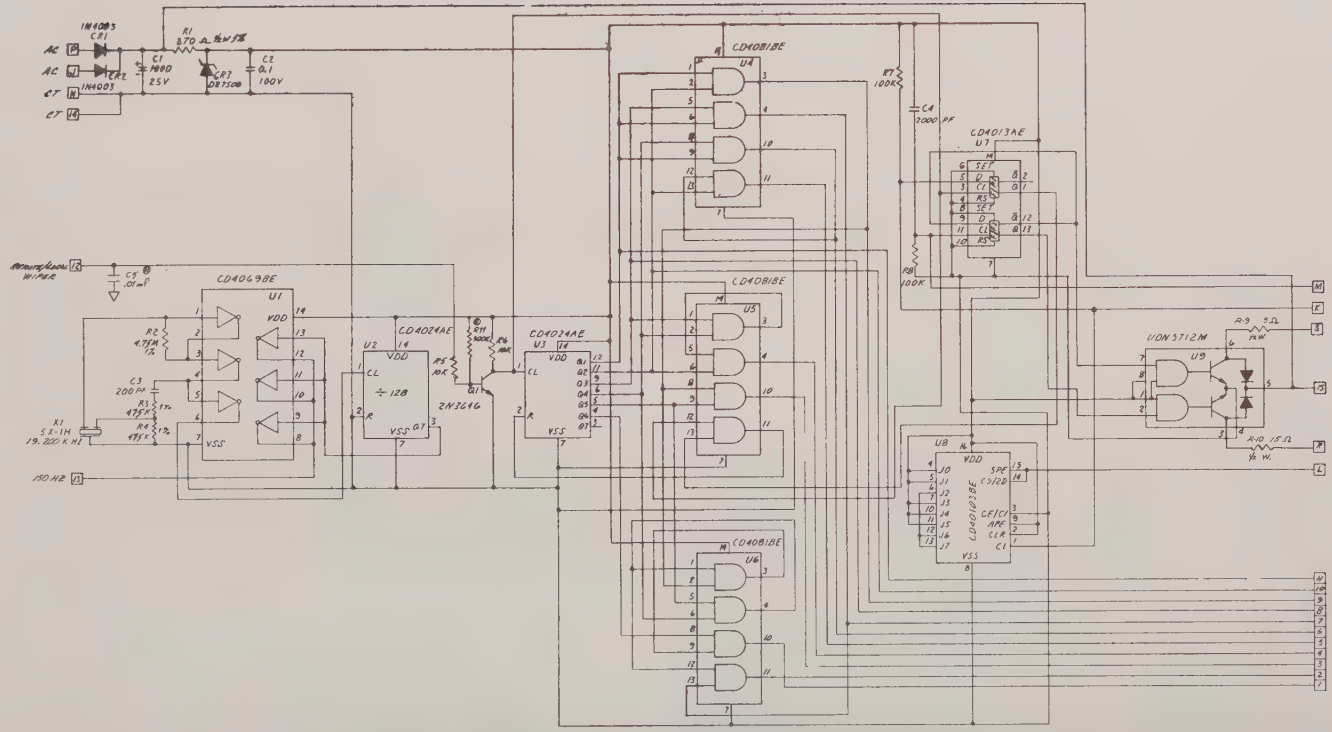
LAST REF DESIGNATORS USED		
A	C	R
1	5	12
REF DESIGNATORS NOT USED		

UNLESS OTHERWISE SPECIFIED	DRAWN	CARPENTER	6 14 78
DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS XX ± .01 XXX ± .005 ANGLES ± 1/2°	CHECK	PATTERSON	6 15 78
	APPD		
	APPD		

ELECTRICAL SCHEMATIC DIAGRAM, PREAMP (PULSE-SERVO)

3. VOLTAGES SHOWN ARE NOMINAL.
2. CAPACITOR VALUES ARE IN MICROFARADS.
1. RESISTOR VALUES ARE IN OHMS

NOTES UNLESS OTHERWISE SPECIFIED



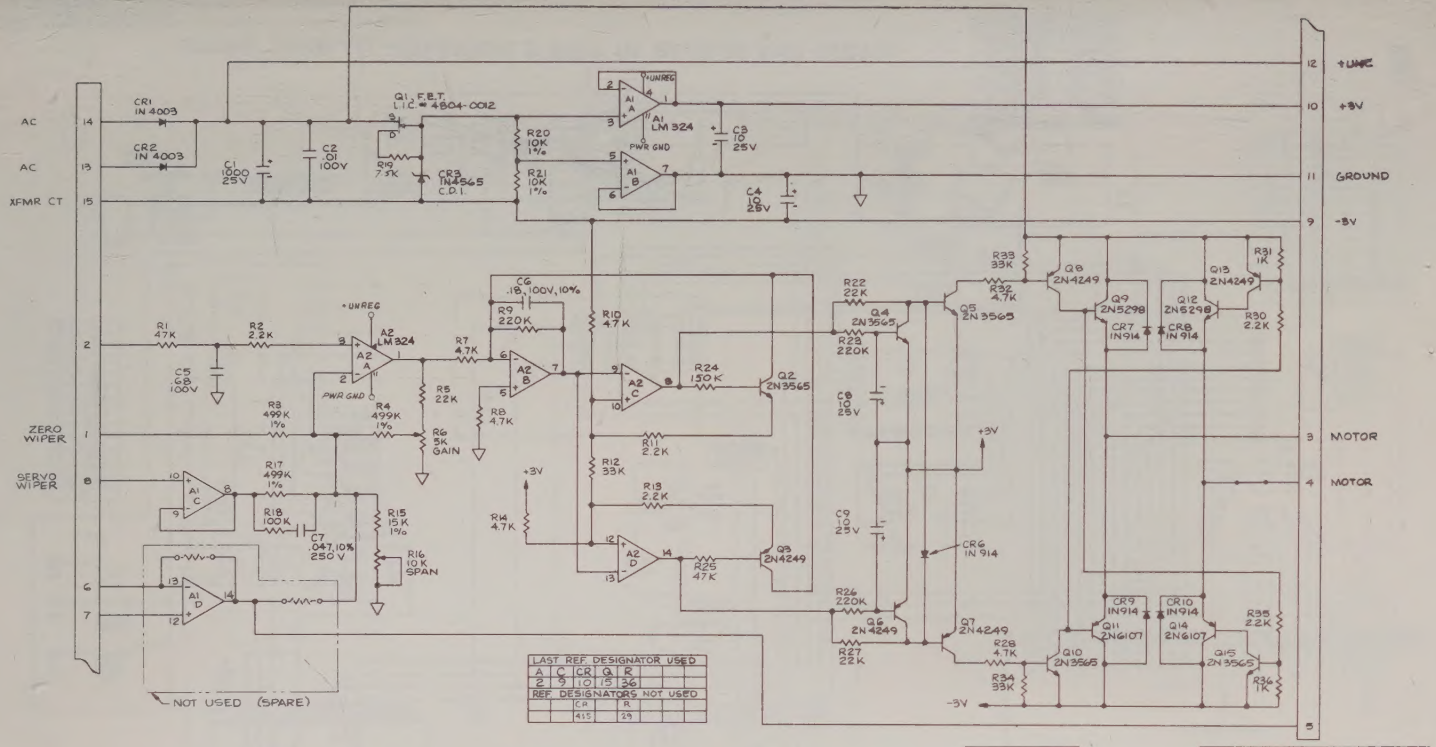
LAST REFERENCE DESIGNATOR USED						
C	CR	Q	R	U	X	
1	3	1	11	3	1	

REFERENCE DESIGNATOR NOT USED

UNLESS OTHERWISE SPECIFIED	DRAWN	D. BASS	3-22-78
DIMENSIONS ARE IN INCHES TOLERANCES	CHECK	M. TOPE	3/27/78
DECIMALS ANGLES .XX ± .01 ± 1/2° .XXX ± .005	APPD.	PATTERSON	3/27/78
	APPD.		
	MODEL NO.		
MATERIAL	FINISH		

ELECTRICAL SCHEMATIC DIAGRAM, STEPPER, 22 SPEED, CRYSTAL CONTROL

SCALE	SIZE	DWG. NO.	REV.
NONE	D	9600-0114	



LAST REF. DESIGNATOR USED							
A	C	CR	Q	R			
2	9	10	15	36			

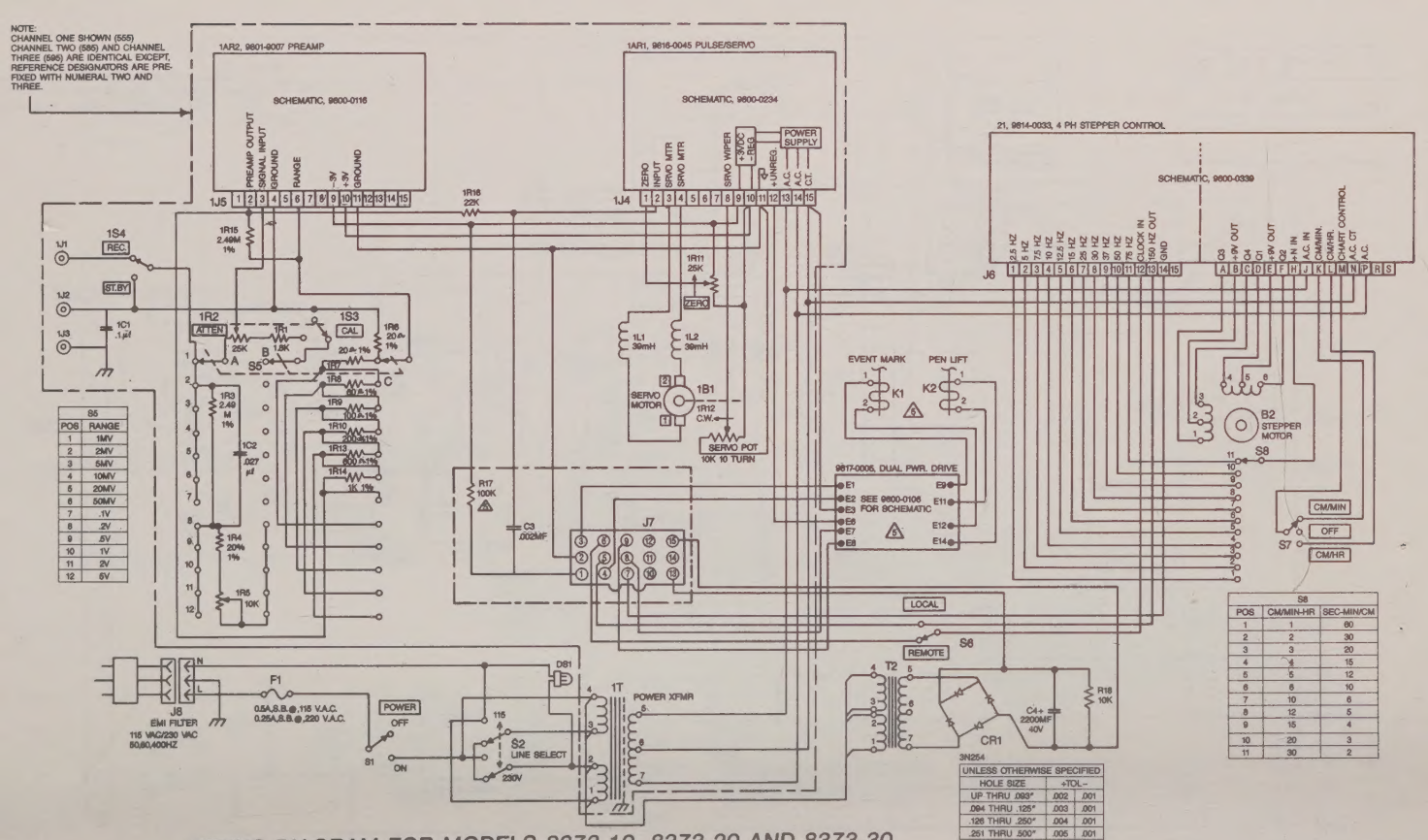
REF. DESIGNATORS NOT USED							
		CR		R			
		415		29			

VOLTAGES SHOWN ARE NOMINAL.
CAPACITOR VALUES ARE IN MICROFARADS.
RESISTOR VALUES ARE IN OHMS, 1/4W, 10%

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
DECIMALS .XX ± .01 .XXX ± .005
ANGLES ± 1/2°
MATERIAL: ——

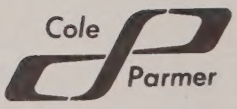
ELECTRICAL SCHEMATIC DIAGRAM PULSE-SERVO

SCALE:	SIZE	DWG. NO.	REV.
NONE	D	9600-0117	D



WIRING DIAGRAM FOR MODELS 8373-10, 8373-20 AND 8373-30

4 EVENT MARK & PEN LIFT NOT PROVIDED ON 0596 SERIES. COMPONENTS NOT INSTALLED.
4 VOLTAGES SHOWN ARE NOMINAL.
3. PANEL MOUNTED CONTROLS ARE IDENTIFIED BY BOXED NOMENCLATURE.
2. CAPACITOR VALUES ARE IN MICROFARADS.
1. RESISTOR VALUES ARE IN OHMS AND 5% UNLESS NOTED.



Cole-Parmer Instrument Company
7425 North Oak Park Avenue, Chicago, IL 60648
1-708-647-7600 or toll-free 1-800-323-4340 (except Alaska)
Fax: 1-708-647-9660 Telex: 28-9405